CLAIMS

What is Claimed is:

1. A method of transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising the steps of:

determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability;

determining an second signal layer modulation carrier power C_U at least in part according to an second signal layer clear sky margin M_U and an second signal layer availability;

modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

modulating the second signal symbols according to a second carrier at the determined second signal layer modulation carrier power to generate the layered modulation signal;

transmitting the modulated first signal symbols and second signal symbols; and

wherein the second signal layer clear sky margin is less than the first signal layer clear sky margin when the first signal layer availability and the second signal layer availability are substantially equal.

2. The method of claim 1, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

3. The method of claim 1, wherein the first signal layer is transmitted on a different frequency range than the second signal layer.

4. The method of claim 1, wherein:

the step of determining the first signal layer modulation carrier power C_L at least in part according to a first layer clear sky margin M_L and a first layer availability comprises the step of determining a first level carrier power C_L according to $C_L = \frac{\beta N T_L}{\alpha}$, wherein $\frac{\beta}{\alpha}$ is the first layer clear sky margin M_L, β comprises a value representing an increase in noise of the layered modulation signal due to atmospheric rain, α comprises a value representing rain attenuation of the layered modulation signal, N comprises a value representing clear-sky thermal noise, and T_L comprises a first signal layer carrier-to-noise threshold level; and

the step of determining the second signal layer modulation carrier power C_U at least in part according to an second layer clear sky margin M_U and a second layer availability comprises the step of determining an second level carrier power C_U according to $C_U = \frac{(\beta N + \alpha C_L) T_U}{\alpha}$, and wherein the second layer clear sky margin $M_U = \frac{(T_L + 1)}{\left(T_L + \frac{\alpha}{\beta}\right)}$ and T_U comprises a second signal layer carrier-to-noise threshold level.

5. The method of claim 1, wherein:

the first signal symbols are modulated according to a first carrier;

the second signal symbols are modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

6. The method of claim 5, further comprising the steps of:

demodulating and decoding the second signal layer to produce the secondsignal symbols;

re-encoding and remodulating the second signal symbols and subtracting the re-encoded and remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

demodulating the first signal layer to produce the first signal symbols.

7. A method of transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising the steps of:

determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability;

determining an second signal layer modulation carrier power C_U at least in part according to an second layer clear sky margin M_U and an second signal layer availability;

modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

modulating the second signal symbols according to a second carrier at the determined second signal layer modulation carrier power ;

transmitting the modulated first signal symbols and the modulated second signal symbols; and

wherein the second signal layer availability is greater than the first signal layer availability and the second signal layer clear sky margin M_U equals $\frac{\frac{\beta_U}{\alpha_U}\beta_U + \beta_L T_L}{\alpha_L + \beta_L T_L}$, wherein α_U at least partially represents the rain attenuation of the second modulation

carrier, α_L at least partially represents the rain attenuation of the first layer modulation carrier, β_U at least partially represents the additional noise in the second modulation carrier due to rain, and β_L at least partially represents the additional noise in the first modulation carrier due to rain.

8. The method of claim 7, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

9. The method of claim 7, wherein $\alpha_U < \alpha_L$ and $\beta_U > \beta_L$.

10. The method of claim 7, wherein the first signal layer is transmitted on a different frequency range than the second signal layer.

11. The method of claim 7, wherein:

the first signal layer is modulated according to a first carrier;

the second signal layer is modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

12. The method of claim 11, further comprising the steps of:

demodulating the second carrier and decoding the second layer to produce the second signal symbols;

re-encoding and remodulating the second signal symbols and subtracting the recoded and remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

demodulating the first carrier and decoding the demodulated first carrier to produce the first signal symbols.

13. An apparatus for transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising:

means for determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability;

means for determining an second signal layer modulation carrier power C_U at least in part according to an second signal layer clear sky margin M_U and an second signal layer availability;

means for modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

means for modulating second signal symbols according to a second carrier at the determined second signal layer modulation carrier power to generate the second signal layer;

means for transmitting the modulated first signal symbols and the modulated second signal symbols; and

wherein the second signal layer clear sky margin is less than the first signal layer clear sky margin when the first signal layer availability and the second signal layer availability are substantially equal.

14. The apparatus of claim 13, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

15. The apparatus of claim 13, wherein the second signal layer modulation is an upper modulation layer and the first signal layer modulation layer is a lower modulation layer.

16. The apparatus of claim 15, wherein:

the means for determining the first signal layer modulation carrier power C_L at least in part according to a first layer clear sky margin M_L and a first layer availability comprises means for determining a first level carrier power C_L according to $C_L = \frac{\beta N T_L}{\alpha}$, wherein $\frac{\beta}{\alpha}$ is the first layer clear sky margin M_L, β comprises a value representing an increase in noise of the layered modulation signal due to atmospheric rain, α comprises a value representing rain attenuation of the layered modulation signal, N comprises a value representing clear-sky thermal noise, and T_L comprises a first signal layer carrier-to-noise threshold level; and

the means for determining the second signal layer modulation carrier power C_U at least in part according to an second layer clear sky margin M_U and a second layer availability comprises means for determining an second level carrier power C_U according to $C_U = \frac{(\beta N + \alpha C_L) T_U}{\alpha}$, and wherein the second layer clear sky margin $M_U = \frac{(T_L + 1)}{\left(T_L + \frac{\alpha}{\beta}\right)}$ and T_U comprises a second signal layer carrier-to-noise threshold level.

17. The apparatus of claim 13, wherein:

the first signal symbols are modulated according to a first carrier;

the second signal symbols are modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

18. The apparatus of claim 17, further comprising:

means for demodulating and decoding the second signal layer to produce the second signal symbols;

means for re-encoding and remodulating the second signal symbols and subtracting the re-encoded and remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

means for demodulating and decoding the first signal layer to produce the first signal symbols.

19. An apparatus for transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising:

means for determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability;

means for determining an second signal layer modulation carrier power C_U at least in part according to an second layer clear sky margin M_U and an second signal layer availability;

means for modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

means for modulating the second signal symbols according to a second carrier at the determined second signal layer modulation carrier power to generate the second modulated signal;

means for transmitting the modulated first signal symbols and the modulated second signal symbols; and

wherein the second signal layer availability is greater than the first signal layer availability and the second signal layer clear sky margin $M_U = \frac{\frac{\beta_U}{\alpha_U}\beta_U + \beta_L T_L}{\alpha_L + \beta_L T_L}$,

wherein α_U at least partially represents the rain attenuation of the second modulation carrier, α_L at least partially represents the rain attenuation of the first layer modulation carrier, β_U at least partially represents the additional noise in the second modulation carrier due to rain, and β_L at least partially represents the additional noise in the first modulation carrier due to rain.

20. The apparatus of claim 19, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

21. The apparatus of claim 19, wherein $\alpha_U < \alpha_L$ and $\beta_U > \beta_L$.

22. The apparatus of claim 19, wherein the first signal layer is transmitted on a different frequency range than the second signal layer..

23. The apparatus of claim 19, wherein:

the first signal layer is modulated according to a first carrier;

the second signal layer is modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

24. The apparatus of claim 23, further comprising:

means for demodulating and decoding the second carrier and decoding the second layer to produce the second signal symbols;

means for re-encoding and remodulating the second signal symbols and subtracting the re-encoded remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

means for demodulating the first carrier and decoding the demodulated first carrier to produce the first signal symbols.

25. An apparatus for transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising:

a processor for determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability, and for determining an second signal layer modulation carrier power C_U at least in part according to an second signal layer clear sky margin M_U and an second signal layer availability;

a modulator, communicatively coupled to the processor, the modulator for modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

a second modulator, communicatively coupled to the processor, the second modulator for modulating second signal symbols according to a second carrier at the determined second signal layer modulation carrier power to generate the second signal layer;

at least one transmitter, communicatively coupled to the modulator and the second modulator, the at least one transmitter for transmitting the modulated first signal symbols and the modulated second signal symbols; and

wherein the second signal layer clear sky margin is less than the first signal layer clear sky margin when the first signal layer availability and the second signal layer availability are substantially equal.

26. The apparatus of claim 25, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

27. The apparatus of claim 25, wherein the second signal layer modulation is an upper modulation layer and the first signal layer modulation layer is a lower modulation layer.

28. The apparatus of claim 27, wherein the processor comprises:

a module for determining a first level carrier power C_L according to $C_L = \frac{\beta N T_L}{\alpha}$, wherein $\frac{\beta}{\alpha}$ is the first layer clear sky margin M_L, β comprises a value representing an increase in noise of the layered modulation signal due to atmospheric rain, α comprises a value representing rain attenuation of the layered modulation signal, N comprises a value representing clear-sky thermal noise, and T_L comprises a first signal layer carrier-to-noise threshold level; and

a second module for determining an second level carrier power C_U according to $C_U = \frac{(\beta N + \alpha C_L) T_U}{\alpha}$, and wherein the second layer clear sky margin $M_U = \frac{(T_L + 1)}{\left(T_L + \frac{\alpha}{\beta}\right)}$ and T_U comprises a second signal layer carrier-to-noise threshold level.

29. The apparatus of claim 25, wherein:

the first signal symbols are modulated according to a first carrier;

the second signal symbols are modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

30. The apparatus of claim 29, further comprising:

a demodulator for demodulating the second layer signal;

a decoder, communicatively coupled to the decoder, for decoding the demodulated second signal layer to produce the second signal symbols;

a re-encoder, communicatively coupled to the decoder, the re-encoder for re-encoding the second signal symbols

a modulator, communicatively coupled to the re-encoder, the modulator for remodulating the re-encoded second signal symbols;

a differencer, communicatively coupled to the modulator, for subtracting the re-encoded and remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

a second demodulator, for demodulating and decoding the first signal layer to produce the first signal symbols.

31. An apparatus for transmitting a layered modulation signal having a first signal layer having first signal symbols and a second signal layer having second signal symbols, comprising:

a processor, for determining a first signal layer modulation carrier power C_L at least in part according to a first signal layer clear sky margin M_L and a first signal layer availability, and for determining an second signal layer modulation carrier power C_U at least in part according to an second layer clear sky margin M_U and an second signal layer availability;

a modulator, communicatively coupled to the processor, the modulator for modulating the first signal symbols according to a first carrier at the determined first signal layer modulation carrier power;

a second modulator, communicatively coupled to the processor, the second modulator for modulating the second signal symbols according to a second carrier at the determined second signal layer modulation carrier power to generate the second modulated signal;

at least one transmitter, communicatively coupled to the second modulator, the second modulator for transmitting the modulated first signal symbols and the modulated second signal symbols; and

wherein the second signal layer availability is greater than the first signal layer availability and the second signal layer clear sky margin $M_U = \frac{\frac{\beta_U}{\alpha_U}\beta_U + \beta_L T_L}{\alpha_L + \beta_L T_L}$,

wherein α_U at least partially represents the rain attenuation of the second modulation carrier, α_L at least partially represents the rain attenuation of the first layer modulation carrier, β_U at least partially represents the additional noise in the second modulation carrier due to rain, and β_L at least partially represents the additional noise in the first modulation carrier due to rain.

32. The apparatus of claim 31, wherein the modulated first signal symbols and the modulated second signal symbols are independently transmitted.

33. The apparatus of claim 31, wherein $\alpha_U < \alpha_L$ and $\beta_U > \beta_L$.

34. The apparatus of claim 31, wherein the first signal layer is transmitted on a different frequency range than the second signal layer.

35. The apparatus of claim 31, wherein:

the first signal layer is modulated according to a first carrier;

the second signal layer is modulated according to a second carrier; and

wherein the first carrier is randomly phased with respect to the second carrier.

36. The apparatus of claim 35, further comprising:

a demodulator, for demodulating and decoding the second carrier and decoding the second layer to produce the second signal symbols;

a re-encoder, for re-encoding the second signal symbols;

a modulator, communicatively coupled to the re-encoder, the modulator for re-modulating the second signal symbols;

a differencer, communicatively coupled to the modulator, for subtracting the re-encoded remodulated second signal symbols from the layered modulation signal to produce the first signal layer; and

a second demodulator, communicatively coupled to the differencer, the second demodulator for demodulating the first carrier and decoding the demodulated first carrier to produce the first signal symbols.

37. The apparatus of claim 31, wherein the first signal layer is transmitted on a different frequency range than the second signal layer.